

## COMPOSITIONS AND METHODS FOR REDUCING ODOR

### RELATED APPLICATION

**[0001]** This application is a non-provisional application which claims the priority of prior provisional application serial number 60/232,151, entitled Compositions And Methods For Reducing Odor, filed September 7, 2000, which is hereby incorporated by reference into this application.

### FIELD OF THE INVENTION

**[0002]** This invention relates to compositions and methods effective for reducing odor. In one embodiment, this invention relates to compositions and methods effective for reducing a wide range of odors using an effective amount of a composition(s) comprising effective amounts of at least one acid, at least one synthetic zeolite and at least one metal, metal oxide, or salt of a metal or metal oxide.

### BACKGROUND OF THE INVENTION

**[0003]** Odors offensive to the human olfactory system originate from a variety of sources including humans and animals, such as pet and animal wastes, and from activities, such as from cooking and from tobacco smoke. Some of these offensive odors can be attributed to odors from specific chemicals like methyl mercaptan, hydrogen sulfide, methyl sulfide, methyl disulfide, trimethylamine, acetaldehyde, n-butyric acid, n-valeric acid, iso-valeric acid and propionic acid and the like. Many of these aforementioned chemicals can arise from partial decomposition of animal and plant wastes. Other odors that are sometimes found to be offensive to the human olfactory system can originate from foods such as garlic and onions either when such foods are fresh or stale due to spoilage. The odors associated with this wide range of sources are complex and can consist of a mixture of different substances including, but not limited to, inorganic bases such as ammonia, organic acids such as butyric acid and neutral organic molecules such as allicin (odor of garlic).

**[0004]** Many compositions and methods have been developed for the purpose of eliminating or controlling odor. However, these methods and compositions have had only limited success because the agents typically used for such purposes either are effective at controlling only a limited range of odors, or control odors by masking them with other odors (fragrances) or have other limitations.

**[0005]** For example, one conventional method of masking such odors often involves the use of fragrances or perfumes. However, masking has disadvantages. Masking does not remove the components of the odors itself, and for many, the masking odor itself is unpleasant. In addition, many odor reducing or masking agents are specific and not effective for controlling all odors. Specifically, amine and ammonia odors are difficult to mask with fragrances.

**[0006]** Sorbants like activated carbon and natural and synthetic zeolites are effective for trapping many odors, but the use of both have disadvantages. For example, activated carbon is unsuitable for use where the sorbant(s) may come in contact with animals, furniture, or carpets, while natural and most synthetic zeolites have low capacities for odors in the presence of moisture. Natural zeolites typically trap odors. However, the capacity of natural zeolites is very limited due to natural zeolites stronger affinity for water than for the odor molecules. Natural zeolites are often used to release fragrances on exposure to moisture rather than to trap odors.

**[0007]** Another method of odor removal is by chemical reaction(s). Chemicals like acids and bases can be used to trap the base and acid components present that cause odors. Acids like butyric acid and hydrogen sulfide can be trapped by bases like sodium bicarbonate (baking soda) while basic compounds like ammonia can be trapped by acids like phosphoric acid. In order to maximize their performance, generally the acid and base components are separated into different traps and the odors are treated sequentially. The use of acids and bases to trap odors is incomplete because these sorbants do not trap neutral odors such as allicin. Consequently, the use of acids and bases alone is insufficient.

**[0008]** In addition to the use of acids and bases for odor removal, metals, metal oxides and metal salts have been used for control of odors by chemical

interactions. In this case, transition metals like copper are particularly effective in trapping odors due to sulfides by forming non-odorous metal complexes with the sulfides. Again, the metals have limited coverage and are ineffective against neutral molecules and ammonia odors.

[0009] Despite the foregoing, need continues to exist in the art to provide a composition and method for effectively reducing odor that is odorless and effectively controls a wide range of odors, including ammonia, amines, sulfur bearing compounds and other malodorous materials, e.g. fatty acids, which are generated from pet litter, household activities and wastes and the like.

### OBJECTS OF THE INVENTION

[0010] It is an object of the present invention to provide safe and effective novel compositions for reducing a wide range of odors, including ammonia, sulfurous odors and neutral organics, which are non-toxic and safe for direct or indirect human or animal contact.

[0011] It is a further object of the invention to provide a method for reducing a wide range of odors using the odor reducing composition(s) of this invention.

[0012] It is a still further object of the invention to provide odor controlling articles containing the odor reducing compositions of the invention that are effective at controlling odors emitted from the articles during use.

[0013] The above and other objects are met in the invention which is described in more non-limiting detail hereinafter.

### SUMMARY OF THE INVENTION

[0014] According to the invention, and in one embodiment, odor reducing compositions are provided comprising at least one acid having a  $pK_a$  greater than about 2.9 and less than about 6, water solubility less than about 45 g/100g  $H_2O$ , and an oral rat  $LD_{50}$  greater than about 2200 mg/kg, at least one synthetic zeolite having at least about 90 percent of its tetrahedral oxide units as  $SiO_2$  tetrahedra, a capacity for adsorbed water of not greater than 10 weight percent when measured at 25 °C and at a water vapor pressure of 4.6 torr, and pore apertures nominally at least 5.5 Å in

diameter, from which the original water of hydration has been substantially removed, and at least one substance selected from the group consisting of metal, metal oxide, a metal salt, and any combination thereof.

[0015] In another embodiment of this invention, a method for removing odors from an odor emitting environment is provided comprising contacting an effective amount of the odor reducing composition of the invention with the odor emitting environment and allowing for a sufficient time to pass for the odor reducing composition to essentially remove the odor.

[0016] In yet another embodiment of this invention, a method for removing odor is provided comprising adding an effective amount of the odor reducing composition of the invention to an article that, in the absence of the odor reducing composition, emits an odor during use, and essentially removing the emitted odor from the article.

[0017] In a still further embodiment of this invention, an article is provided comprising an article that, in the absence of the odor reducing composition of the invention, emits an odor during use, and the odor reducing composition of the invention in an amount effective at controlling odors emitted from the article during use.

#### DETAILED DESCRIPTION OF THE INVENTION

[0018] This invention comprises a novel composition for reducing odor. The composition is safe and effective at reducing a broad array of odors and is practically non-toxic. Further, unlike prior odor reducing compositions, the present composition is safe for direct or indirect animal contact. As used herein the term "animal" includes human beings.

[0019] The present inventive composition for reducing odor comprises at least one acid having a  $pK_a$  greater than about 2.9 and less than about 6, water solubility less than about 45 g/100g  $H_2O$ , and an oral rat  $LD_{50}$  greater than about 2200 mg/kg, at least one synthetic zeolite having at least about 90 percent of its tetrahedral oxide units as  $SiO_2$  tetrahedra, a capacity for adsorbed water of not greater than about 10

weight percent when measured at 25 °C and at a water vapor pressure of 4.6 torr, and pore apertures nominally at least about 5.5 Å in diameter, from which the original water of hydration has been substantially removed, and a substance selected from the group consisting of metal, metal oxide, a salt of a metal or metal oxide, and any combination thereof. In the practice of this invention, the composition of this invention is produced by admixing the readily available components together. This is contrary to prior art odor reducing compositions that describe zeolites coated with metal compounds or serve as a support for metal compounds. Zeolites that are coated with metal compounds, or serve as an inert support for metal compounds, are not suitable for use in the present invention because the metallic coating of zeolites result in at least partial inactivation of the adsorption properties of the zeolite. Accordingly, the zeolite becomes inert, and does not serve an active role in the adsorption of odors as in the present invention.

[0020] The invention comprises at least one acid having a  $pK_a$  greater than about 2.9 and less than about 6, water solubility less than about 45 g/100g  $H_2O$ , and an oral rat  $LD_{50}$  greater than about 2200 mg/kg. Preferably, the acid is essentially odorless. In addition, it is currently preferred that the first  $pK_a$  ( $pK_{a1}$ ) of the acid is greater than about 2.9 and less than about 6. In one embodiment, at least one acid is selected from the group consisting of an organic acid, amino acid, and mixtures thereof. Examples of suitable acids useful herein include but are not limited to carboxylic acids, polycarboxylic acids having two or more  $-COOH$  groups, amino acids, polyamino acids having two or more  $-COOH$  groups, and any suitable combination thereof. Accordingly, the acid may be adipic, polyacrylic, polyaspartic, aspartic, glutamic, mixtures thereof and the like.

[0021] Illustrative dicarboxylic acids that may be used in the present invention include, but are not limited to, adipic, aspartic, cyclohexane-1:1-dicarboxylic, cystine, dimethylmalonic, fumaric, sorbic, glutaric, methylsuccinic, itaconic, succinic and tartaric acid, mixtures thereof and the like. Preferred acids useful in this invention include adipic, fumaric, sorbic, aspartic, mixtures of, and the like.

**[0022]** The odor reducing composition(s) of this invention also includes at least one of a metal, metal oxide, a salt of a metal or metal oxide, or any combination thereof. Metal oxides that may be used herein, include but are not limited to, zinc oxide, copper oxide, iron oxide, manganese oxide, tin oxide, silver oxide, mixtures thereof and the like. Preferred metal oxides include zinc oxide, copper oxide and iron oxide, with zinc oxide and copper oxide being most preferred.

**[0023]** In another embodiment, a metal may also be used. Suitable metals according to the invention include, but are not limited to, zinc, copper, iron, manganese, tin and silver. Preferred metals are zinc, iron and copper, with zinc and copper being most preferred.

**[0024]** If desired, a salt of a metal or metal oxide may also be employed in the odor reducing composition(s) of this invention. Any salt of a suitable metal or metal oxide may be used including, but not limited to, salts of zinc, copper, iron, manganese, tin and silver. Preferred salts are salts of zinc or zinc oxide, iron or iron oxide and copper or copper oxide, with salts of zinc, copper, zinc oxide and copper oxide being more preferred. Salts of copper that may be used include, but are not limited to  $\text{CuSO}_4$ . It is generally desired to use environmentally friendly salts including but not limited to metal sulfates, halides, carbonates, bicarbonates, organic acid salts, mixtures thereof and the like. Examples of salts which are effective in the practice of this invention include zinc sulfate, copper sulfate, zinc chloride, copper chloride, zinc aspartate, mixtures thereof and the like. Zinc salts are most preferred.

**[0025]** At least one zeolite/molecular sieve, is used as an active agent in the present invention. Zeolites useful herein include those zeolites and molecular sieves where sufficient sites and/or pores are available for carrying out this invention so as to provide ample means for adsorption, desorption, diffusion and the like. The zeolite of the odor reducing composition of the invention has an effective number of pores or sites available for the practice of this invention. Zeolites, generally, are three-dimensional, microporous, crystalline solids with well defined structures that contain aluminum, silicon and oxygen in their regular framework. Zeolites are minerals that are mined in many parts of the world and also produced synthetically. Prior art odor

reducing compositions have used natural zeolites for odor adsorption. However, natural zeolites have a high affinity for water. Therefore, they are unsuitable in the present invention because the odorous compounds are displaced during use. Natural zeolites are essentially inert when used in the present composition, particularly when such compositions are contacted with water during use. The effective zeolites are those zeolites that have an affinity for organic compounds, but a sufficiently low affinity for water such that there is essentially no displacement of organic compounds. Accordingly, only synthetic zeolites are suitable for the present invention. Therefore, as used herein, the term "zeolite" means synthetic zeolite.

[0026] Suitable zeolites useful herein include high-silica zeolites. Examples of high-silica zeolites suitable for the present invention include, but are not limited, to the synthetic high-silica zeolites described in U.S. Patent Nos. 5,013,335 and 4,795,482 to Marcus and Gioffre, et al., which issued on May 7, 1991 and January 3, 1989, respectively, and which are herein incorporated by reference in their entirety.

[0027] In a specific embodiment, the zeolite of the present invention is at least partially activated, at least about 90 percent of the framework tetrahedral oxide units are  $\text{SiO}_2$  tetrahedra, have pore diameters of at least 5.5 Å and have a capacity for adsorbed water not greater than 10 weight percent when measured at 25° C and at a water vapor pressure of 4.6 torr. In one embodiment, the zeolite is an aluminosilicate having a framework  $\text{SiO}_2/\text{Al}_2\text{O}_3$  molar ratio greater than 35. In an alternate embodiment, the activated zeolite is comprised of a mixture of a silica polymorph and an aluminosilicate having a framework  $\text{SiO}_2/\text{Al}_2\text{O}_3$  molar ratio in the range of about 200 to about 500. Illustratively, commercially available zeolites suitable for use in the present invention include, Zeolyst™ CBV 901, available from Zeolyst International, Valley Forge, PA, USA; and Smellrite®, available from Universal Oil Products, Des Plaines, IL, USA.

[0028] The odor reducing composition of the invention comprises an acid in the range of about 0.1% to about 99.7%, metal, metal oxide or a salt of a metal or metal oxide and any combination thereof, in the range of about 0.1% to about 99.7%, and synthetic zeolite in the range of about 0.1% to about 99.7% of the total

composition based on the sum of these three components being 100%. In use, the relative ratios of the active components may be tailored as desired for specific odor reduction applications.

**[0029]** In another embodiment the composition of this invention comprises an acid in the range from about 33 to about 99%; metal, oxide or a salt of a metal oxide and any combination thereof in the range from about 0.5 to about 40% and zeolite from about 5% to about 50% based on the sum of three components being 100%.

**[0030]** Preferably, in one other embodiment, the metal, metal oxide, or salt and acid combined are present in the range of about 24% to about 99.7% of the total composition and zeolite comprises in the range of about 0.3% to about 76% of the total composition.

**[0031]** In yet another embodiment, metal, metal oxide, or salt and acid combined are present in the range of about 50% to about 98% of the total composition and zeolite comprises about 2% to about 50% of the total composition.

**[0032]** In a specific embodiment of the invention, relating to use in a deodorizing composition, e.g. in a cat litter deodorizer, carpet deodorizer or shoe odor deodorizer, the acid comprises about 85-95% of the total composition, the metal oxide, metal or salt comprises about 0.5 to about 5% of the total composition and the synthetic zeolite comprises about 1% to about 12% of the total composition based on the sum of these three components being 100%.

**[0033]** In a more specific embodiment, the odor reducing composition of the invention comprises about 0.5 to about 2.0% metal, metal oxide, or salt, preferably ZnO, about 9 to about 11% zeolite; and about 88 to about 89.5% acid, preferably aspartic acid or fumaric acid.

**[0034]** In yet another specific embodiment, the odor reducing composition of the invention comprises about 11% aspartic acid, about 24.5% adipic acid, about 43% ZnO and about 21.5% zeolite.

**[0035]** In still another specific embodiment, the odor reducing composition of the invention comprises about 90-94% acid, preferably aspartic acid or fumaric acid, about 1-3% metal, metal oxide, or salt, preferably ZnO, and about 5-7% zeolite.



**[0036]** In yet another embodiment, an odor reducing composition of the invention includes a diluent. The amount of diluent in the odor reducing composition of the invention is from 0 to about 70%, i.e. the amount of acid, metal, metal oxide, or salt, and zeolite in the odor reducing composition being about 30 to 100%. Any convenient and compatible diluent, that is generally inert, may be used, including but not limited to sodium sulfate, sodium chloride, sodium bicarbonate, sodium carbonate, clay, sepiolite, palygorskite, activated carbon, activated carbon filter, activated alumina, sepiolite-admixed paper, silica gel, activated clay, vermiculite, diatomaceous earth, pulp, fibers, cloth, polymeric porous body, and a natural zeolite, e.g. a natural, inorganic zeolite such as clinoptilolite. The diluent may be selected based on the undesired odor or application.

**[0037]** In a specific embodiment where a diluent is used, the odor reducing composition of the invention comprises about 30-38% aspartic acid or fumaric acid, about 0.5-1% ZnO, about 1-2% zeolite, and about 60-67% clinoptilolite.

**[0038]** In addition, in an embodiment of the invention for reducing odor, the composition optionally may contain other components if desired, including, but not limited to, biocides, chelants and absorbents, mixtures thereof and the like. Other components that may be optionally incorporated usefully into a composition of this invention for reducing odor are selected in accordance with specific applications of the invention after reading this specification.

**[0039]** In some instances, it may be desirable to combine the above described composition for reducing odor directly with a substance that, in the absence of the odor reducing composition, emits an odor during use. As used herein, the term "odor emitting" means to diffuse or contain a pleasant or unpleasant scent that stimulates the olfactory organ. Accordingly, as used herein, an odor emitting substance is any substance capable of stimulating the olfactory organ, whether offensive or non-offensive. Further, an odor emitting environment is an environment capable of stimulating the olfactory organ, whether offensive or non-offensive non-limiting. Examples of non-offensive odors include perfume and sweet smells non-limiting. Examples of offensive odors include ammonia and sulfurous odors.

**[0040]** The odor reducing composition of the invention may be used alone or may be used in combination with other materials or articles to remove odor. The odor reducing composition of the invention is simply admixed with the materials or articles to remove the odor emitting substances. For example, the odor reducing composition of the invention may be incorporated into personal care articles like foot powders, pads, laundry preparations, pet litters and cleaning products. The composition of the invention may also be used with deodorizers, such as carpet deodorizers and vehicle deodorizers. Often, deodorizers work by masking odors with perfumes and other odors. Prior art odor reducing substances have failed to produce a composition that effectively adsorbs odor without the use of perfuming masks, which are offensive to many. While some in the past may have succeeded to produce compositions that adsorb certain odors, no prior art composition or method has been proven to effectively adsorb the broad spectrum of odors effectively adsorbed by the present invention. For example, any commercially available pet litter may be admixed with an effective amount of the composition of the present invention to adsorb any masking odors that may be irritating or offensive. Also, a commercially available odor controlling substance like carpet deodorizer, may be combined with the present composition to increase the overall effectiveness of its odor adsorption. Accordingly, less of the commercially available odor controlling substances is necessary for effective odor control, making the incorporation of the odor reducing composition of the invention cost effective.

**[0041]** The concentration of the odor reducing composition of the invention is largely dependent upon the specific application of this invention and would be readily apparent to one of ordinary skill in the art. In one embodiment of the invention, the odor reducing composition of the invention is admixed with pet litter to reduce any emitted odor or to improve the odor reducing capabilities of the litter itself. The odor reducing composition of the invention is added to the used or unused pet litter in an amount effective to reduce any undesired odors emitted from the litter thereby producing an odor-controlled pet litter. Any effective amount of the odor reducing

composition of the invention may be added to used or unused pet litter or other articles, which in the absence of the present invention emits an odor.

**[0042]** In one embodiment, the odor-controlled pet litter comprises in the range of about 0.1% to about 20% of the odor reducing composition of the invention.

**[0043]** In a preferred embodiment, the odor-controlled pet litter comprises in the range of about 0.1% to about 10% of the odor reducing composition of the invention.

**[0044]** In a more preferred embodiment, the odor-controlled pet litter comprises in the range of about 1% to about 5% of the odor reducing composition of the invention.

**[0045]** In yet another embodiment of this invention, the odor reducing composition of the invention is optionally admixed with one or more effective deodorizers to reduce odors emitted from the deodorizer or to increase the odor reducing capabilities of the deodorizer itself. Where the odor reducing composition of the invention comprises deodorizers or is used in some useful combination with one or more deodorizers.

**[0046]** In another embodiment comprising cat litter deodorizer, carpet and or shoe deodorizer, the invention comprises about 88 to about 89.5% acid, about 9 to about 11% zeolite and about 0.5 to about 2% metal oxide based on the sum of these components being 100%.

**[0047]** In some instances, it may be impractical to directly combine the present compositions with substances that, in the absence of the present invention, emit odor. For example, many personal care articles like menstrual pads and diapers cannot be effectively admixed with the present composition. Therefore, and in one embodiment of the invention, the odor reducing composition of the invention may be simply placed in contact with or incorporated within articles, which in the absence of the odor reducing composition of the invention emit odor during use, to thereby produce odor-controlled articles. The odor reducing composition of the invention may be placed in contact with or incorporated into any article to remove the odor produced during use of that article. For example, the odor reducing composition of

the invention may be placed in contact with or incorporated into pads, including diapers, adult incontinence products, and menstrual pads, tissue, lagoons, bandages, dressings, surgical sponges, personal care articles, cleaning products, food tray liners, room and vehicle, e.g. auto, truck, air transport and trains, deodorizers like solid air fresheners, bedding, garbage bags, clothing, shoes and carpet. The present composition may be incorporated within the above articles in any conventional and effective manner known to those of skill in the art.

[0048] A method for reducing odor using the above odor reducing composition(s) is also provided according to the present invention. The method for reducing odor includes contacting an effective amount of an odor reducing composition of the invention with at least one article, which, in the absence of the odor reducing composition of the invention, emits an odor during use, and removing the emitted odor from the article. Further, according to the invention, any article that emits odor in the absence of the odor reducing composition of the invention is suitable herein. Unlike prior art odor control compositions, the present composition effectively removes a wide variety of odors including ammonia and sulfurous odors. Without being bound by theory it is believed that the mechanism of odor removal of this invention includes physical and chemical sorption. In an embodiment, the composition of the present invention is admixed with or placed in contact with pads, lagoons, tanks, animal waste, bandages, dressings, surgical sponges, catamenial devices, beef, poultry, and fish tray liners, personal care articles, foot powders, laundry preparations, pet litters such as cat litter and dog litter, cleaning products, deodorizers, bedding, floors, garbage cans, diaper pails, refrigerators, carpet and any substance that emits odor in the absence of the odor reducing composition of the invention. The composition then removes the emitted odor.

[0049] In another embodiment, an effective amount of the odor reducing composition of the invention is placed in contact with an odor emitting environment and a sufficient amount of time is allowed to pass for the odor reducing composition to essentially and effectively remove the odor.

**[0050]** In one specific embodiment, the composition of the present invention is enclosed in an article that allows for movement and containment of the composition of this invention. The article may be placed in an odor emitting environment where odor control is desired. For example, the present composition may be placed in a box, bound in a cloth, or bag and placed in a closet, bathroom, or drawer or the like to control odor. The only restriction is that the article which encloses or contains a composition of this invention be sufficiently porous for the odor reducing composition to remove any undesired odor.

**[0051]** An effective amount of the odor reducing composition of the present invention is used in the method for reducing odor of the invention. An effective amount is the amount necessary for the odor reducing composition of the invention present to effectively remove an emitted odor from an odor emitting article or environment. Accordingly, the effective amount used in the present method varies depending on the specific odors emitted, as well as the environment of use among other factors. However, the effective amount of the odor reducing composition of the invention necessary for removing an odor would be readily apparent to one skilled in the art without undue experimentation after reading this specification.

**[0052]** All references cited herein are hereby incorporated by reference for their relevant teachings. Accordingly, any reference cited herein and not specifically incorporated by reference is, nevertheless, incorporated by reference in its entirety as if part of the present specification.

## EXAMPLES

**[0053]** The following examples illustrate specific embodiments of the invention without limiting the scope of the invention in any way.

**[0054]** In the examples which follow, aspartic acid was acquired from Solutia Inc., 385 Marshall Avenue, St. Louis, MO 63119, CBV 901 zeolite catalyst was acquired from Zeolyst International at Valley Forge, PA; Smellrite® was acquired from Universal Oil Products, 307 Fellowship Road, Mount Laurel, IL.

**[0055]** Unless otherwise specified, use of “%” is on a weight basis.

## EXAMPLE 1

[0056] Two samples (Samples 1-2) of an odor reducing composition of the invention and a comparative sample were prepared by adding the following to three individual jars, stirring the contents of the jars, capping the jar and shaking the jars.

- Sample-1      100 g zinc oxide;  
                  100 g L-aspartic; and  
                  100 g zeolite (CBV 901).
- Sample-2      100 g zinc oxide;  
                  100 g L-aspartic; and  
                  100 g Smellrite®.
- \*Sample-3     100 g zinc oxide;  
                  100 g L-aspartic; and  
                  100 g zeolite (UOP PA 451).
- \* comparative sample

[0057] These two samples (Samples 1-2) were then tested against comparative samples of unused Arm & Hammer® cat litter deodorizer and Sample-3 by placing three teaspoons of each of the samples and the unused Arm & Hammer® cat litter deodorizer in a jar containing used pet litter. The results demonstrate that samples containing Smellrite® or Zeolyst™ CBV 901 are preferred over samples containing PA 451. The results are summarized in Table 1 below.

Table 1

Sample Composition	Amount added to pet litter	Efficacy
Sample-1	3 teaspoons	No odor
Sample-2	3 teaspoons	No odor
Sample-3*	3 teaspoons	Odor
Arm & Hammer® cat litter deodorizer*	3 teaspoons	Masks odor with fragrance effectively
1/3 Sample-1 + 2/3 Sample-3	3 teaspoons	weak odor
1/3 Sample-2 + 2/3 Sample-3	3 teaspoons	very weak odor

\*comparative sample

**[0058]** The results also indicate that compositions of this invention utilizing Smellrite® and Zeolyst™ CBV 901 were demonstrated to be very effective in removing odors caused by solid cat litter, while zeolite UOP PA 451 (a comparative composition) was less effective.

## **EXAMPLE 2**

### **ODOR CONTROL TESTING OF AMMONIA**

**[0059]** The following (odor reducing) compositions illustrative of this invention were prepared for odor control testing. Specifically, the ability to remove ammonia was tested for various odor reducing compositions. Samples were prepared by following the method of Example 1. 29.5%  $\text{NH}_4\text{OH}$  was added to each of the following odor reducing compositions. 2 or 3 drops of 29.5%  $\text{NH}_4\text{OH}$  (10 drops = 0.28 g) were added to about 10 g of the odor reducing compositions in a 2 oz. jar. The 29.5%  $\text{NH}_4\text{OH}$  and the odor reducing compositions were admixed and allowed to set for about 10 minutes with the lid tightly closed. If there was no odor upon removal of the lid, as determined by smell, additional 29.5%  $\text{NH}_4\text{OH}$  was added and the test was repeated. As used herein, the grams of 29.5%  $\text{NH}_4\text{OH}$  adsorbed represents the maximum amount of 29.5%  $\text{NH}_4\text{OH}$  removed by 10 grams of the respective samples. Accordingly, at any concentration level above the amounts indicated, an ammonia odor was emitted from the mixture. The results are summarized in Tables 2 and 3.

**[0060]** The above results and those in Tables 2 and 3 below indicate that both L-aspartic and adipic acid are demonstrated to be very effective in removing odors caused by ammonia.

Table 2

Odor Reducing Composition Number	L-aspartic acid	zinc oxide	Zeolyst™ CBV 901	Advera® 401	13X powder (diluent zeolite)	Grams of 29.5% NH <sub>4</sub> OH** in a 10g sample
1	33 g	33 g	33 g			0.76 g
2	33 g	33 g	3 g	30 g		1.12 g
3	33 g	33 g	3 g		30 g	0.50 g
4	33 g	33 g	11 g	22 g		1.96 g
5	33 g	33 g	11 g		22 g	0.36 g
6	33 g	33 g	6 g	27 g		1.54 g
7	33 g	33 g	6 g		27 g	0.45 g
8	40 g	40 g	20 g			1.90 g
9	33 g	44 g	22			2.10 g
*10	50 g	50 g				1.48 g

\*comparative sample

\*\*amount of 29.5% NH<sub>4</sub>OH added before persistent odor of ammonia is detectable

Table 3

Odor Reducing Composition Number	Adipic acid	Zinc Oxide	Zeolyst™ CBV 901	Advera® 401	13X powder (diluent zeolite)	Grams of 29.5% NH <sub>4</sub> OH** in a 10g sample
1	33 g	33 g	33 g			2.10 g
2	33 g	33 g	3 g	30 g		1.68 g
3	33 g	33 g	3 g		30 g	0.56 g
4	33 g	33 g	11 g	22 g		2.10 g
5	33 g	33 g	11 g		22 g	0.42 g
6	33 g	33 g	6 g	27 g		2.10 g
7	33 g	33 g	6 g		27 g	0.70 g
8	40 g	40 g	20 g			2.24 g
9	33 g	44 g	22 g			2.24 g
*10	50 g	50 g				2.10 g

\*comparative sample

\*\*Amount of 29.5% NH<sub>4</sub>OH added before persistent odor of ammonia is detectable.



### EXAMPLE 3

#### ODOR CONTROL TESTING OF AMMONIA USING ODOR REDUCING COMPOSITIONS OF THE PRESENT INVENTION

[0061] 3.3 g of each acid indicated in Table 8 (below) were admixed with 3.3 g zinc oxide, available from Fisher Scientific and 3.3 g Advera® 401 (PQ Corporation) to form an odor reducing composition in accordance with the present invention. About 10 g of the respective odor reducing compositions were placed into individual 2 oz. jars. 29.5 %  $\text{NH}_4\text{OH}$  was added to the odor reducing compositions, capped and allowed to set for 10 minutes. If there was no odor, detected qualitatively after ten minutes elapsed, more 29.5%  $\text{NH}_4\text{OH}$  was added and the test was repeated until an odor was emitted. The results of this Example are summarized in Table 4 below and demonstrate that odors caused by ammonia can be removed by the action of odor reducing compositions of the inventions that include these acids.

Table 4

Acid used in the odor reducing composition	Drops/grams 29.5% $\text{NH}_4\text{OH}$ **
*Ascorbic acid	70 = 1.96 g
*Citric acid	70 = 1.96 g
Fumaric acid	120 = 3.36 g
Glutaric acid	85 = 2.38 g
Methyl Succinic acid	90 = 2.52 g
*Malic acid	40 = 1.12 g
o-Phthalic acid	85 = 2.38 g
Succinic acid	90 = 2.52 g
tartaric acid	90 = 2.52 g

\*comparative samples

\*\*Amount of 29.5%  $\text{NH}_4\text{OH}$  added before persistent odor of ammonia is detectable.

### EXAMPLE 4

#### COMPARATIVE ODOR CONTROL TESTING OF AMMONIA USING ODOR REDUCING COMPOSITIONS OF THE PRESENT INVENTION AND COMMERCIALY AVAILABLE ZEOLITES ALONE

**[0062]** Samples were prepared following the procedure of Example 1 above. 29.5% NH<sub>4</sub>OH was added dropwise (10 drops = 0.28 g) to 10 g of each of the odor reducing compositions, or zeolites shown in Table 5 in a 2 oz jar. Covered with a lid, the jar is shaken and allowed to set for 10 min. If there is no odor, additional 29.5% NH<sub>4</sub>OH is added and the test is repeated until odor is emitted. The results of this Example are summarized in Table 5.

Table 5

Odor Reducing Composition / Zeolite	Grams of 29.5% NH <sub>4</sub> OH**
33.4% L-aspartic acid 33.3% zinc oxide 33.3% Zeolyst™ CBV 901	1.54 g
30% Fumaric acid 10% Sorbic acid 30% Zinc Sulfate 30% Smellrite®	3.22 g
20% L-aspartic acid 20% Fumaric acid 20% Zinc Oxide 30% Advera® 401 10% Smellrite®	2.24 g
20% L-aspartic acid 20% Fumaric acid 5% Zinc Sulfate 15% Copper Sulfate 30% Advera® 401 10% Smellrite®	1.68 g
* Zeolyst™ CBV 901	0.14 g
* Smellrite®	0.56 g

\* control sample

\*\*Amount of 29.5% NH<sub>4</sub>OH added before persistent odor of ammonia is detectable.

**[0063]** The results of this Example show the ability of the odor control compositions in accordance with the present invention to remove significantly more ammonia than the use of zeolites alone.

## EXAMPLE 5

### COMPARATIVE ODOR CONTROL TESTING OF AMMONIA USING ODOR REDUCING COMPOSITIONS OF THE PRESENT INVENTION AND OTHER COMMERCIALY AVAILABLE ODOR CONTROL COMPOSITIONS

[0064] 10 g of each of the odor control compositions listed below were placed into a 2 oz jar. 29.5%  $\text{NH}_4\text{OH}$ , from Fisher Scientific, was added to each jar, the jar was shaken and allowed to set for about 10 min. The odor was monitored. If there was no odor after ten minutes had elapsed, more 29.5%  $\text{NH}_4\text{OH}$  was added and the test repeated. The results of this Example are summarized in Table 6.

Table 6

Odor Control Composition	29.5% $\text{NH}_4\text{OH}$ **
*Tidy Cat® Scoop (Ralston Purina Company)	0.06 g
*Super Scoop™ (Arm & Hammer®)	0.28 g
*Ammo Cat® (Aquarium Pharm.)	0.28 g
*Pearl Fresh (PETsMART)	0.56 g
*Odor Pro (Odor Pro)	0.28 g
*Odor Sentry (Ammonia Hold)	0.14 g
*Odorz Out (No Stink)	0.28 g
*Tidy Cat® cat box deodorizer (Ralston Purina Company)	Very Strong Odor <0.14 g
*Cat litter deodorizer (Arm & Hammer®)	Strong odor <0.14 g
60% L-aspartic; 10% Smellrite®; and 30% zinc oxide.	1.54 g

\*comparative example

\*\*Amount of 29.5%  $\text{NH}_4\text{OH}$  added before persistent odor of ammonia is detectable.

[0065] The results of this Example indicate that the compositions for reducing odor of the present invention remove substantially more ammonia odor than other commercially available odor control compositions.

## EXAMPLE 6

### COMPOSITION FOR REDUCING ODOR OF THE PRESENT INVENTION USED IN COMBINATION WITH PET LITTER

[0066] 60 g aspartic acid, 10 g Smellrite® and 30 g zinc oxide were admixed to produce a composition for reducing odor in accordance with the present invention. A comparative sample of Tidy Cat® scoop, commercially available from Ralston Purina Company, St. Louis, MO, was combined with the composition in a 2 oz. jar at the amounts indicated in the Table 7 below to form four distinct odor reducing compositions in accordance with the present invention. 29.5%  $\text{NH}_4\text{OH}$ , available from Fisher Scientific, was added to each of the final compositions dropwise until an ammonia odor was emitted. If no odor was emitted additional 29.5%  $\text{NH}_4\text{OH}$  was added and the test was repeated until an odor was emitted. The results of this Example are summarized in Table 7.

Table 7

Tidy Cat® scoop	Odor Reducing Composition of the Present Invention	29.5% $\text{NH}_4\text{OH}$ **
10 g*	0 g	0.08 g
9 g	1 g	0.42 g
8 g	2 g	0.84 g
7 g	3 g	0.98 g
0	10 g	1.54 g

\*control sample

\*\* Amount of 29.5%  $\text{NH}_4\text{OH}$  added before persistent odor of ammonia is detectable.

[0067] The results of this Example indicate that the odor reducing composition of the present invention adsorbed substantially more ammonia odor than Tidy Cat® Scoop alone. The results also indicated that the odor reducing compositions formed by the addition of the composition of the present invention to other pet litters resulted in enhanced adsorption capabilities as compared to the use of the pet litter alone.

## EXAMPLE 7

### COMPARATIVE ODOR CONTROL TESTING OF SULFIDE

[0068] A 0.2% aqueous sulfide solution was prepared by mixing sodium sulfide, acetic acid and water. An odor reducing composition of the present invention was prepared by mixing 60 g L-aspartic acid, 10 g Smellrite® and 30 g zinc oxide. 0.1 gram of the above odor reducing composition was placed in a 2 oz jar and a lid was placed on the jar. One gram of the other commercially available odor control compositions were placed in individual 2 oz. jars. The sulfide solution was added to each of the jars dropwise and admixed with the respective compositions. If no sulfide was detected after approximately 10 minutes, additional sodium sulfide was added and the test was repeated until sulfide was detected. The results are summarized in Table 8 below.

Table 8

Sample	Drops of 0.2% sodium sulfide solution
Odor Reducing Composition	140-250
*Tidy Cat® scoop (Ralston Purina)	3
*Super Scoop™ (Arm & Hammer)	2
*Ammo Cat® (Aquarium Pharmaceuticals, Inc., Chalfont, PA)	1
*ExquisiCat® Pearl Fresh cat litter(PETsMART, Inc. Phoenix, AZ)	2
*Odor Pro (Odor Pro®)	2
*Odor Sentry™ pet odor eliminator (Ammonia Hold, Inc.®, Little Rock, AR)	2
*Odorz Out (No Stink)	8
*Tidy Cat box deodorizer (Ralston Purina)	1
*Cat Litter deodorizer (Arm & Hammer)	1

\*comparative examples

[0069] This Example shows that the odor reducing formulation is at least 15 times as effective as commercially available products available for the removal of sulfide odors.

## EXAMPLE 8

### EFFECT OF ZINC CONCENTRATION

[0070] A 0.2% aqueous sulfide solution was prepared by combining sodium sulfide, acetic acid and water. Compositions for reducing odor were prepared in accordance with the present invention by mixing L-aspartic acid, zinc oxide, Smellrite® and CBV 901 in the proportions indicated below in Table 9. 0.1 g of the resulting compositions were each placed in a jar. The sulfide solution was added dropwise to each of the jars until an odor was emitted. If no odor was emitted after approximately ten minutes, additional sulfide solution was added, and the test was repeated until an odor was emitted. Separately, in different containers, 29.5%  $\text{NH}_4\text{OH}$  was added to each 10g sample until an odor of ammonia was detected. The results of this Example are summarized in Table 9 below.

Table 9

% L- aspartic	% zinc Oxide	% Smellrite®	% Zeolyst™ CBV 901	Drops Sulfide Solution	Drops 29.5% $\text{NH}_4\text{OH}$ **
60	2	10	28	15	95
60	5	10	25	25	90
60	10	10	20	60	80
60	20	10	10	125	65
60	30	10	0	225	55

\*\* Amount of 29.5%  $\text{NH}_4\text{OH}$  added before persistent odor of ammonia is detectable.

[0071] The results demonstrate that these formulations are effective in controlling both ammonia and sulfide odors over a broad range of zeolite and metal oxide concentrations.

## EXAMPLE 9

### ODOR CONTROL TESTING OF SULFUR USING COMPOSITIONS FOR REDUCING ODOR COMPRISING LOW CONCENTRATIONS OF METAL OXIDE

[0072] Zinc oxide, Smellrite® and L-aspartic acid were admixed to form a composition for reducing odor in accordance with the invention having the following approximate composition: 0.5% zinc oxide, 10% Smellrite® and 89.5% L-aspartic. Lead acetate strips were used to detect the presence of sulfide after 10 minutes. A 0.2% aqueous sulfide solution was prepared by mixing sodium sulfide and acetic acid in water. The sulfide solution was added dropwise to 1 g of the composition. If an odor was not emitted, additional sulfide solution was added until odor was emitted. 14 drops of sulfide solution was added before an odor was emitted.

[0073] Zinc oxide, Smellrite® and L-aspartic acid were admixed to form a composition for reducing odor in accordance with the invention having the following approximate composition: 0.5% zinc oxide, 10% Smellrite®, 59.5% Clinoptilolite and 30% L-aspartic acid were admixed to form a composition for reducing odor in accordance with the invention. A 0.2% aqueous sulfide solution was prepared by mixing sodium sulfide, acetic acid and water. The sulfide solution was added dropwise to 1 g of the composition. If an odor was not emitted, additional sulfide solution was added until an odor was emitted. 10 drops of sulfide solution was added before an odor was emitted.

[0074] Zinc oxide, Smellrite® and L-aspartic acid were admixed to form a composition for reducing odor in accordance with the invention having the following approximate composition: 1.0% zinc oxide, 10% Smellrite® and 89% L-aspartic acid. A 0.2% aqueous sulfide solution was prepared by mixing sodium sulfide, acetic acid and water. The sulfide solution was added dropwise to 1 g of the composition until an odor was emitted. 24 drops of sulfide solution was adsorbed before an odor was emitted.

[0075] Zinc oxide, Smellrite® and L-aspartic acid were admixed to form a composition for reducing odor in accordance with the invention having the following

approximate composition: 2.0% zinc oxide, 10% Smellrite® and 88% L-aspartic were admixed to form a composition for reducing odor in accordance with the invention. A 0.2% aqueous sulfide solution was prepared by mixing sodium sulfide, acetic acid and water. The sulfide solution was added dropwise to 1 g of the composition until an odor is emitted. 140 drops of sulfide solution was adsorbed before an odor was emitted.

[0076] These results indicate the preferred range of zinc oxide in an odor reducing composition of this invention for use in an application where sulfurous odors are emitted.

#### EXAMPLE 10 – COMPARATIVE

##### ODOR CONTROL TESTING OF B-CYCLODEXTRIN HYDRATE AND FEBREZE®

[0077] 0.5 g B-cyclodextrin hydrate was placed in a 2 oz jar with 2 drops of 0.2% aqueous sulfide solution and a lead acetate strip. The lead acetate strip turned black indicating sulfide present in the air.

[0078] 5.0 g of B-cyclodextrin hydrate was placed in a 2 oz jar with 2 drops of 29.5%  $\text{NH}_4\text{OH}$ . A strong odor of ammonia was emitted.

[0079] 1.0 g of liquid Febreze® (Proctor & Gamble) was placed in a 2 oz jar with 1 drop of a 0.2% aqueous sulfide solution and a lead acetate strip. The lead acetate strip turned black.

[0080] 10.0 g of liquid Febreze® was placed in a 2 oz jar with 5 drops of 29.5%  $\text{NH}_4\text{OH}$ . A strong odor was detected.

[0081] The results of this example demonstrate that neither B-cyclodextrin hydrate nor Febreze® effectively remove ammonia or sulfide odors.

#### EXAMPLE 11 – COMPARATIVE

##### CAT LITTER ODOR CONTROL

[0082] 10 g of each of the samples listed Table 11 below were placed in individual 2 oz. jars. 29.5%  $\text{NH}_4\text{OH}$  was added dropwise to the jar and admixed until an odor was emitted.



[0083] 1 g of each of the samples listed in the Table 11 were placed in individual 2 oz. jars. A 0.2% aqueous sulfide solution was added dropwise to each of the samples until an odor was detected. The results are summarized in Table 11 below.

Table 11

Samples	Drops Ammonia adsorbed	Drops Sulfur adsorbed
*Arm & Hammer® Carpet & Room Deodorizer	< 10 drops	< 3 drops
*Arm & Hammer® Cat Litter Deodorizer	< 10 drops	< 3 drops
*Simple Solution Carpet & Room Deodorizer	< 10 drops	< 3 drops
*Glade Pet Odors Carpet & Room Deodorizer	< 10 drops	< 3 drops
*Stop Litter Odor	< 10 drops	< 3 drops
*Pet Clear All Natural	< 10 drops	< 3 drops
*Captain Cat® Cat Litter Deodorizer	< 10 drops	< 3 drops

\*comparative example

[0084] The results indicate that the odor reducing composition of the invention is more effective at removing both ammonia and sulfide odors than these commercially available compositions for odor reduction.

#### EXAMPLE 12

[0085] The effectiveness of odor reducing compositions of the invention in controlling the odors of 3-methylindole, sodium methoxide, methylsalicylate, triethylamine, isovaleric acid, and dimethylsulfide was compared against the effectiveness of the individual components of the compositions and baking soda, i.e. sodium bicarbonate.

**[0086]** Two odor reducing compositions of the invention were tested. The first odor reducing composition of the invention was 89% L-aspartic acid, 1% ZnO, and 10% Smellrite® zeolite (Invention #1). The second odor reducing composition of the invention was 88% L-aspartic acid, 2% ZnO, and 10% Smellrite® zeolite (Invention #2). The odor emitting compounds were tested neat, and triethylamine (0.1%), dimethylsulfide (0.1%), and isovaleric acid (0.82%) were also tested as solutions in water. All odor emitting compounds except methylsalicylate were obtained from Aldrich Chemical Company. Methylsalicylate was obtained from Sigma Chemical Company.

**[0087]** The amount of neat odor emitting compounds added to each serum bottle is given in Table 12. In the tests using the water solutions of the odor emitting compounds, 500 µL of the solutions were used for all samples.

Table 12

Sample	3-methyl-indole (mg)	Sodium meth-oxide (mg)	Methyl-salicylate (mg)	Triethyl-amine (mg)	Isovaleric acid (mg)	Dimethyl-sulfide (mg)
Control – as is	18	22	23	22	23	17
Invention #1	20	29	25	19	22	28
Smellrite	21	21	26	20	21	22
L-aspartic acid	22	19	25	24	23	28
Zinc oxide	35	21	28	25	21	21
Baking soda	30	19	19	19	21	19

**[0088]** The amount of the samples used in the tests were as follows: Invention #1 (1.0g), Invention #2 (1.0g), Smellrite® (0.1 g), L-aspartic acid (0.89g for Invention #1 and 0.88g for Invention #2), zinc oxide (0.01g for Invention #1 and 0.02g for Invention #2), and baking soda (1.0 g).

**[0089]** Samples were prepared using 20 mL serum bottles with septum caps, and gas tight syringes were used to sample the headspace in the serum bottles. The sample was weighed into the serum bottle, the odor emitting compounds were added, and the sample bottles capped. The sample and the odor emitting compound in the serum bottle was mixed in each case. The serum bottle was then allowed to stand for 30 minutes and a 100 µL sample was taken from headspace of the serum bottle using a gas tight syringe and then injected into a gas chromatograph (GC) for analysis.

**[0090]** The GC analysis was performed using a H-P 5890-II GC with a FID detector and a Split/Splitless injector, and a H-P 3396 integrator. The column used was a capillary H-P Ultra-2 (50m x 0.32mm x 0.52µm). The GC conditions used were: injector temperature = 300°C, detector temperature = 330°C, oven temperature program = 70°C initial hold for 4 min., raise temperature 7°C/min. to 235°C, hold at 235°C for 4 min. with total run length of 31.6 min. The split was turned off at injection and turned on after 30 seconds.

**[0091]** The GC results are presented in Tables 13 and 15 (area counts in headspace) and Tables 14 and 16 (% Odor). % Odor was expressed as % of control ("as-is") and calculated as follows: (area sample/area control) x 100. Complete removal of odor is represented as 0% and the control is 100%.

Table 13  
GC Analysis – Area Counts in Headspace

Sample	3-methyl-indole	Sodium meth-oxide	Methyl-salicylate	Triethyl-amine	Isovaleric Acid	Dimethyl-sulfide
Control – as is	4000	20378	38790	8590381	53990	10670136
Invention #1	0	0	2049	7591005	20048	8803891
Smellrite	1226	0	15397	5754746	46745	14319488
L-aspartic acid	3580	19129	33871	6236176	47685	4056472
Zinc oxide	2706	38097	32463	7113763	48121	7087306
Baking soda	2669	16261	38721	3019376	2594	12928528

**Table 14**  
**% Odor**

Sample	3-methyl-indole	Sodium meth-oxide	Methyl-salicylate	Triethyl-amine	Isovaleric Acid	Dimethyl-sulfide
Control – as is	100%	100%	100%	100%	100%	100%
Invention #1	0%	0%	5.3%	88.4%	37.1%	82.5%
Smellrite	30.7%	0%	39.7%	67.%	86.6%	134.2%
L-aspartic acid	89.5%	93.9%	87.3%	72.6%	88.3%	38.%
Zinc oxide	67.7%	187.%	83.7%	82.8%	89.1%	66.4%
Baking soda	66.7%	79.8%	99.8%	35.2%	4.8%	121.2%

**Table 15**  
**GC Analysis – Area Counts in Headspace**

Sample	Triethylamine (0.1% in water)	Isovaleric acid (0.82% in water)	Dimethylsulfide (0.1% in water)
Control – as is	23500	3655	153633
Invention #2	0	485	2459
Smellrite	0	0	1426
L-aspartic acid	0	509	126284
Zinc oxide	18640	0	148158
Baking soda	4473	319	143740

Table 16  
% Odor

Sample	Triethylamine (0.1% in water)	Isovaleric acid (0.82% in water)	Dimethylsulfide (0.1% in water)
Control – as is	100%	100%	100%
Invention #2	0%	13.3%	1.6%
Smellrite	0%	0%	0.9%
L-aspartic acid	0%	13.9%	82.2%
Zinc oxide	79.3%	0%	96.4%
Baking soda	19.%	8.7%	93.6%

[0092] The results demonstrate that the odor reducing compositions of the invention (Invention #1 and Invention #2) reduced the amount of odor for each odor emitting compound compared to the control samples. In addition, the Invention #1 sample demonstrated improved performance over the performance of the individual components for odor emitting compounds 3-methylindole, methylsalicylate, and isovaleric acid. The Invention #1 sample also demonstrated equivalent overall effectiveness to Smellrite® zeolite for sodium methoxide. It is believed that the neat samples of triethylamine and dimethylsulfide were used at too high a loading, i.e. the amount of odor causing material greatly exceeded the capacity of the odor reducing materials being tested.

[0093] Therefore, the data clearly demonstrate that the odor reducing compositions of the invention are effective for a wide range of odor emitting compounds.

[0094] The present invention has been described in what is considered to represent its preferred embodiments. However, it should be noted that the invention may be practiced otherwise than as specifically illustrated and described without departing from the spirit and the scope of the invention.